UNIVERSIDADE FEDERAL DE SERGIPE
PROGRAMA DE PÓS-GRADUAÇÃO EM ODONTOLOGIA

INCIDÊNCIA DE FRATURA RADICULAR EM DENTES SUBMETIDOS À TERAPIA ENDODÔNTICA E RESTAURADOS COM PINOS DE FIBRA OU PINOS METÁLICOS: REVISÃO SISTEMÁTICA E METANÁLISE

Aracaju

dezembro 2014

FABRICIO ENEAS DINIZ DE FIGUEIREDO

INCIDÊNCIA DE FRATURA RADICULAR EM DENTES SUBMETIDOS À TERAPIA ENDODÔNTICA E RESTAURADOS COM PINOS DE FIBRA OU PINOS METÁLICOS: REVISÃO SISTEMÁTICA E METANÁLISE

Dissertação apresentada ao Programa de Pós-Graduação em Odontologia da Universidade Federal de Sergipe, para obtenção do título de Mestre em Odontologia.

Orientador: Prof. Dr. André Luis Faria e Silva

Aracaju

2014

FICHA

Figueiredo, Fabrício Enéas Diniz de
F475 Incidência de fratura radicular em dentes submetidos à terapia endodôntica e restaurados com pinos de fibra ou pinos metálicos: revisão sistemática e metanálise / Fabrício Enéas Diniz de Figueiredo ; orientador André Luiz Faria e Silva. – Aracaju, 2014.
45 f.

Dissertação (mestrado em Ciências da Saúde) – Universidade Federal de Sergipe, 2014.

1. Tratamento de canal radicular. 2. Técnica para redentor intrarradicular. 3. Revisão sistemática. 4. Metanálise. I. Faria e Silva, André Luiz, orient. II. Título.

CDU 616.314.18

CATALOGRÁFICA ELABORADA PELA BIBLIOTECA BISAU
UNIVERSIDADE FEDERAL DE SERGIPE

UNIVERSIDADE FEDERAL DE SERGIPE
PRÓ-REITORIA DE PÓS-GRADUAÇÃO E PESQUISA
PROGRAMA DE PÓS-GRADUAÇÃO EM ODONTOLOGIA

Ata da sessão de Defesa de Dissertação de Mestrado de **FABRICIO ENEAS DINIZ DE FIGUEIREDO**

Às nove horas do dia vinte e seis de Janeiro de dois mil e quinze, realizou-se no Auditório do CCBBS ,no Campus da Saúde da Universidade Federal de Sergipe, a sessão pública de defesa de dissertação de Mestrado em Odontologia de **FABRICIO ENEAS DINIZ DE FIGUEIREDO** sob o título: **" INCIDÊNCIA DE FRATURA RADICULAR EM DENTES SUBMETIDOS À TERAPIA ENDODÔNTICA E RESTAURADOS COM PINOS DE FIBRA OU PINOS METÁLICOS: REVISÃO SISTEMÁTICA E METANÁLISE"** presidida pelo Prof. Dr. André Luis Faria e Silva, na qualidade de orientador, que por sua vez passou a palavra ao candidato para proceder à apresentação do seu trabalho. Logo após, o primeiro examinador, Prof. Dr. Carlos José Soares, arguiu o candidato que teve igual período para defesa. O mesmo aconteceu com o segundo examinador, Prof. Dr. Luis Roberto Marcondes Martins. Em seguida, o Prof. Dr. André Luis Faria e Silva, orientador do candidato, teceu comentários sobre o trabalho apresentado. Encerrada esta etapa, os presentes retiraram-se do recinto, permanecendo apenas a banca examinadora para avaliação. Após esta, a banca decidiu considerar o candidato **APROVADO**. Nada mais havendo a tratar, a presente ata foi lavrada e, depois de lida e aprovada, será assinada pela banca examinadora e pelo mestrando.

Aracaju, 26 de Janeiro de 2015

Prof. Dr. André Luis Faria e Silva
Orientador

Prof. Dr. Carlos José Soares
1ª Examinador (UFU)

Prof. Dr. Luis Roberto Marcondes Martins
2ª Examinador (UNICAMP)

Fabrício Enéas Diniz de Figueiredo
Mestrando

Dedico este trabalho

À DEUS...para que este trabalho e que minha formação sejam pequenos tijolos em sua obra de amor e bondade para a humanidade

A meu filhinho Vinicius... Por quem enfrentei o desafio de fazer este trabalho, para poder proporcionar-lhe um futuro melhor, e, principalmente, para que servi-lhe de exemplo; que na vida, é possível alcançar qualquer sonho, desde que se escolha o caminho dos homens de bem: o trabalho duro, a dedicação, o amor e o respeito ao próximo, a bondade e a honestidade, a humildade, e a fé que DEUS nos dará toda coragem de que precisamos.

AGRADECIMENTOS

A meu orientador, o Professor Dr. André Luis Faria e Silva, por ter sido o melhor orientador que um aluno pode ter. Ensinar aos bons alunos é tarefa fácil. Difícil, é ensinar ao aluno que tem dificuldades: ter paciência de esperar o tempo do aluno, saber a dose certa entre o incentivo e a cobrança, escutar anseios e medos não como mestre, mas como um pai. Tudo isso e muito mais o senhor fez com maestria. Professor André, foi uma honra trabalhar com o senhor.

Ao professor Dr. Paulo Ricardo Saquete Martins-Filho, cuja colaboração foi decisiva para a conclusão deste trabalho. Professor, muito obrigado.

A meus pais, Eduardo Eneas de Figueiredo e Eveline Diniz de Figueiredo, por todo o apoio e amor incondicional; e aos meus irmãos, Eduardo Henrique e Flavio Vinicius, e as suas respectivas companheiras, Aline e Vanessa, por todos os conselhos na área de língua inglesa e na parte de computação. Amo vocês.

À minha namorada, Anne Carolinee, simplesmente por estar ao meu lado durante todo este tempo. Também amo você.

A toda turma da Universidade Federal de Uberlândia, que me acolheu de braços abertos, e ao professor Dr, Carlos José Soares, por ter me recebido e tratado como um de seus alunos.

Aos professores, colegas e funcionários do programa de pós-graduação em Odontologia da Universidade Federal de Sergipe, por tornar o trabalho mais leve. Também a CAPES e a FAPITEC, pelo apoio financeiro.

A FUNESA e a prefeitura municipal de Nossa Senhora do Socorro – SE, por muitas vezes terem me liberado do trabalho, para que eu pudesse cumprir as exigências do programa.

E, finalmente, à DEUS, por ter me proporcionado esta oportunidade.

“Não te desamparem a bondade e a integridade; ata-as ao pescoço; escreve-as na tábua de teu coração e acharás graça e boa compreensão diante de DEUS e dos homens”.

“Quem é sábio procura aprender, mas os tolos estão satisfeitos com sua própria ignorância”.

“Viste um homem diligente em sua obra? Perante Reis será posto; não permanecerá entre os de posição inferior”.

“Para ser sábio, é preciso temer a DEUS, o senhor”

Salomão

RESUMO

Dentes submetidos à tratamento endodôntico geralmente apresentam grande destruição coronária. Para restaurá-los, o uso de retentor intrarradicular se faz necessário para melhorar a retenção da restauração. Apesar do sucesso clínico, falhas catastróficas têm sido atribuídas ao seu uso. O objetivo desta revisão sistemática foi analisar o resultado de ensaios clínicos e estudos de coorte que reportam a taxa de incidência de fraturas radiculares associadas ao uso de pinos intrarradiculares. A hipótese foi que dentes restaurados com uso de pinos metálicos apresentam maior incidência de fraturas radiculares que aqueles restaurados com de pino de fibra. Até Janeiro de 2014, buscou-se por estudos clínicos que avaliaram o índice de fraturas radiculares relacionadas ao uso de retentores intrarradiculares metálicos ou de fibra de vidro em dentes submetidos à tratamento endodôntico com tempo de acompanhamento superior a cinco anos. Sete ensaios clínicos randomizados e sete estudos de coorte foram incluídos. A taxa de sobrevivência estimada foi de 90% (95% intervalo de confiança {IC} 85,5 – 93,3) para pinos metálicos e 83,9% (IC 95%, 67,6 – 92,8) para pinos de fibra. A taxa de incidência total de fraturas radiculares (falhas catastróficas) foi similar entre pinos metálicos e de fibra. Pinos metálicos pré-fabricados e pinos de fibra de carbono apresentaram taxa de incidência de fraturas radiculares duas vezes maior quando comparadas com núcleos metálicos fundidos e pinos de fibra de vidro respectivamente. Os resultados deste estudo não demonstraram diferenças significantes na taxa de incidência de fraturas radiculares entre pinos metálicos e de fibra. Entretanto, os estudos incluídos nesta revisão apresentaram alto risco de viés, portanto, há necessidade de se realizarem estudos clínicos bem delineados para confirmar estes achados.

Palavras-chave: Tratamento de canal radicular; técnica para retentor intraradicular, Revisão Sistemática e Metanálise

ABSTRACT

Endodontically treated teeth have commonly lost most of their coronal structure. In order to restore them, an intrarradicular retainer is required to improve the restorations retention. Event though they have a proper clinical performance, their use has been related to failures such as root fractures. The aim of this systematic review was to analyze the outcome of clinical trials and cohort studies evaluating the post-retained restorations regarding the incidence rate of root fractures. The tested hypothesis was that the incidence rate related to the use of metal posts is higher than that of fiber posts. A search for clinical studies reporting the incidence of root fractures of restorations retained with fiber-reinforced composite posts or metal posts of endodontically treated teeth with more than 5-year of follow-up was conducted from inception to January 2014. Seven randomized clinical trials and 7 cohort studies were included. The overall incidence rate of root fractures was 5.13 (95% CI, 4.05-6.21) per 1000 posts-year. An almost 2-fold increase in the incidence rate of root fractures for prefabricated metal posts and carbon fiber posts compared with cast metal posts and glass fiber posts was observed, respectively. The pooled survival rate was 90% (95% CI, 85.5-93.3) for metal-based posts and 83.9% (95%, CI 67.6-92.8) for fiber-reinforced posts. The results of this study do not support the indication of fiber-reinforced posts based on a reduction of catastrophic failures. However, this review demonstrated the need for further well-designed clinical studies evaluating intra-radicular retainers

Key-words: endodontically-treated teeth; post and core technique; dental restoration failure; meta-analysis.

SUMÁRIO

1 - INTRODUÇÃO

Reabilitar dentes submetidos a tratamento endodôntico continua a ser tema controverso no meio odontológico e desafio para o dentista que vai executá-lo. Enquanto dentes com boa estrutura dental remanescente podem ser reabilitados com uma restauração direta, dentes com grande perda de estrutura dental remanescente geralmente necessitam da instalação de um pino intrarradicular para melhorar a retenção da restauração. Existem diversos tipos de pino no mercado; e não há evidência que um sistema apresente melhor desempenho clínico que outro (1). Além disso, a instalação de pino intrarradicular gera tensão na raiz, o que pode levar fratura desta e perda do dente (1). Portanto, para minimizar os riscos de fratura radicular e melhorar o prognóstico da restauração, é fundamental que o dentista conheça todas as características do sistema de pino que vai utilizar.

Por favorecerem mais a estética, pinos de fibra reforçados têm se tornado mais populares do que núcleos metálicos fundidos nos últimos anos. Além disto, as propriedades mecânicas destes pinos também podem ter contribuído para esta mudança. Pinos de fibra de vidro apresentam módulo de elasticidade similar ao da dentina, o que tem sido associado a baixa incidência de fraturas radiculares (1,2)

Uma revisão sistemática de estudos *in vitro* demonstrou que a incidência de fraturas radiculares é maior quando pinos metálicos são utilizados, em comparação com o uso de pinos de fibra (3). O principal motivo estaria relacionado ao alto módulo de elasticidade dos pinos metálicos, que concentraria mais tensões na raiz, promovendo maior incidência de fraturas radiculares (3). No entanto, recente estudo de elementos finitos demonstrou restaurações retidas com pinos de fibra resultavam em maior concentração de tensão na raiz, principalmente quando a há falha na união entre o pino e a superfície da raiz (4). Esse mesmo estudo demonstrou que essas raízes estavam menos propensas a sofrerem fratura devido à tendência do pino e ou núcleo fraturarem antes da raiz.

Clinicamente, a redução na incidência de fraturas radiculares – fraturas essas que não permitem a troca da restauração – pode ser, muitas vezes, mais importante do que a taxa de sobrevida da restauração. Porém, o objetivo da maior parte dos estudos de revisão sobre o assunto revisões foi avaliar a taxa de sobrevida dessas restaurações. Portanto, o objetivo desta revisão foi analisar o resultado de ensaios clínicos e estudos de coorte que avaliaram o desempenho de restaurações retidas a pino no que concerne a incidência de fraturas

radiculares. A hipótese é que a incidência de fraturas radiculares relacionadas ao uso de pinos metálicos é maior que a relacionada ao uso de pinos de fibra. Além disto, também é objetivo deste estudo comparar a taxa de sobrevida dos dois sistemas de retentores intra-radiculares.

2. OBJETIVOS

2.1 Geral:

O propósito deste estudo foi avaliar o desempenho clínico de retentores intrarradiculares metálicos e de fibra.

2.2 Específicos:

- Comparar a taxa de incidência de falhas catastróficas – fraturas radiculares – entre pinos metálicos e pinos de fibra;
- Comparar a taxa de incidência de falhas não catastróficas entre pinos metálicos e pinos de fibra;
- Comparar a taxa de sobrevida entre pinos metálicos e pinos de fibra.

3. METODOLOGIA

Esta revisão sistemática e metanálise foram conduzidas de acordo com as recomendações do PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) e MOOSE (*Meta-Analysis of Observational Studies in Epidemiology*). Para formular a questão da pesquisa, a estratégia de busca e para esclarecer os critérios de elegibilidade, a estratégia PICO (*Population, Intervention, Comparison, Outcome*) foi utilizada.

3.1 Critérios de Elegibilidade

Foram incluídos ensaios clínicos randomizados e estudos de coorte que reportavam a taxa de incidência de fratura radicular associada a restaurações retidas com pinos de fibra reforçados e\ou pinos metálicos. Os artigos foram selecionados se cumprissem os seguintes critérios:

- Estudos clínicos que compararam taxas de incidência de fratura radicular entre pinos metálicos e pinos de fibra, ou que reportaram a taxa de um deles;
- Estudos conduzidos em humanos;
- Estudos com média de acompanhamento superior há cinco anos;

Fratura radicular foi definida como o desfecho primário, enquanto que falhas endodônticas – insucesso exclusivo da terapia endodôntica; a restauração permanente intacta - taxa de sobrevida, descolamento da coroa, descolamento do pino e fraturas do núcleo\coroa foram usados como desfecho secundário (5). Os estudos que não possibilitaram a extração de dados para os desfechos de interesse, estudos *in vitro*, estudos de revisão e estudos com média de acompanhamento inferior a cinco anos foram excluídos. Sempre que um estudo publicou resultados para o mesmo grupo de pacientes, foi escolhido o relato que continha a melhor descrição dos dados, evitando-se a duplicação de dados.

3.2 Estratégia de busca

Na base de dados MEDLINE (www.pubmed.com), foi realizada busca por ensaios clínicos randomizados e por estudos de coorte, sem restrições com relação ao ano de publicação, até Janeiro de 2014 utilizando os seguintes termos: (“*nonvital tooth” OR “devitalized tooth” OR “pulpless tooth” OR “endodontically treated tooth”) AND ("fiber post" OR "metallic post" OR "cast dowel" OR "dowel" OR "metal post" OR "carbon-fiber post" OR "glass-fiber post" OR "quartz-fiber post" OR "fiber-reinforced post" OR "post core systems" OR "post and core technique") AND (exp cohort studies OR cohort OR controlled clinical trial OR epidemiologic methods OR clinical trial*). Também foi realizada busca por dissertações e teses no banco de dados *OpenThesis* utilizando estratégia similar à usada na busca no MEDLINE. Além da procura nas bases de dados, também foi realizada busca manual de referências cruzadas de artigos originais e revisões para identificar estudos adicionais. Não foi imposta nenhuma restrição com relação ao idioma de publicação.

3.3 Extração dos dados e desfechos

Dois revisores independentes analisaram os títulos e resumos dos artigos identificados pela busca e selecionaram aqueles com potencial de terem dados relevantes. O texto completo destes estudos foi analisado e aqueles que estavam de acordo com os critérios de elegibilidade foram incluídos na revisão. Os dados foram então extraídos independentemente pelos dois revisores. Divergências entre os dois revisores foram solucionadas ou por consenso, ou por um terceiro revisor.

3.4 Avaliação do Risco de Viés

A ferramenta de avaliação de risco de viés da Cochrane foi utilizada para avaliar a qualidade metodológica dos ensaios clínicos randomizados selecionados. Dois revisores avaliaram, independentemente, a qualidade dos estudos utilizando os seguintes critérios:

randomização, alocação selada (viés de seleção); cegamento dos participantes e operadores (viés de performance); relato seletivo (viés de relato); e ouros riscos de viés (não descrição da localização do dente ou da quantidade de estrutura coronária remanescente). A resposta para cada critério foi relatada como baixo risco de viés, alto risco de viés e risco de viés não claro (6).

Os estudos de coorte foram avaliados usando modificação da escala de *Newcastle-Ottawa* (NOS) (7) e incluiu avaliações da representatividade do número da amostra, seleção de grupo de comparação (se os participantes foram selecionados da mesma fonte, isto é, mesma instituição ou base de dados), averiguação da exposição por arquivos seguros, desfecho de interesse não estar presente no início do estudo, fatores de confundimento ou outros fatores usados para parear, ou como controle na análise; avaliação do desfecho por exame clínico e radiográfico, tempo de seguimento adequado para fator de estudo ($\geq$ 5 anos), perda de seguimento que não produza viés. Esses itens não foram unidos para determinar o escore de qualidade. Ao invés disto, as informações relevantes para cada domínio foram tabuladas para permitir transparência na avaliação. A escala NOS também foi usada por dois revisores independentes, e discordâncias foram solucionadas por consenso ou por um terceiro revisor.

3.5 Análise dos dados

A incidência de fraturas radiculares e de falhas não catastróficas foi calculada dividindo-se o numero de eventos pelo período de risco para todos os pinos incluídos no período do estudo, por 1000 pinos-ano de seguimento. Se o total de pinos-ano não foi relatado, então o calculo foi feito pela multiplicação do numero de pinos sob seguimento com a média de duração do seguimento. Intervalos de confiança (IC) foram baseados na aproximação normal e calculados utilizando o número de pinos e pinos-ano. Usou-se constante de 0,5 de continuidade como ajuste para estudos com zero eventos (8).

Metanálise das taxas de sobrevida sem ajustes para o tempo de seguimento foi realizada dividindo-se o número de pinos sobreviventes pelo total de pinos incluídos no período de estudo. A análise de Kaplan-Meier não pôde ser realizada uma vez que a maioria dos estudos não reportou tempo de acompanhamento preciso para cada evento. IC foram calculados utilizando a aproximação normal. Quando, em um estudo, a taxa de sobrevida relatada foi de 100%, foi utilizada uma correção contínua da taxa de sobrevida para 99%.

Heterogeneidade estatística foi investigada utilizando o teste Cochran Q e o índice I^2. Para a estatística Q, um valor de p menor que 0,10 foi usado como indicador de variabilidade interno (9). I^2 foi interpretado como a proporção de variação total entre os estudos devido à variabilidade, e um valor >75% foi considerado como medida de heterogeneidade (10). Análise de subgrupo de acordo com o tipo de estudo (ensaio clínico randomizado x estudo de coorte), tamanho da amostra (<100 pinos x ≥100 pinos), e tipo de pino (pino metálico pré-fabricado x núcleo metálico fundido; pino de resina reforçado por fibra de carbono x pino de resina reforçado por fibra de vidro) foram conduzidos para explorar potenciais fontes de heterogeneidade entre os estudos. Para a metanálise da taxa de sobrevida, foi realizada análise estratificada de acordo com o tempo de acompanhamento.

As taxas estimadas foram calculadas usando os modelos de efeitos fixos ou os modelos de efeitos randômicos, dependendo da heterogeneidade entre os estudos. Na ausência de alta heterogeneidade, foi utilizado o modelo de efeitos fixos pelo método de Mantel-Haenzel para combinar os dados, assumindo que havia tamanho de efeito similar e que as diferenças entre cada estudo foram ao acaso. Quando foi observada alta heterogeneidade, as estimativa resultante da combinação dos resultados e os IC correspondentes foram calculados baseados nos modelo de efeitos randômicos pelo método de DerSimonian. No modelo de metanálise por efeitos randômicos, assumiu-se que as taxas de estudos individuais variavam ao redor da medida-sumário (11). O gráfico de floresta (*forest plot)* foi utilizado para ilustrar a

estimativa combinada e os intervalos de confiança de 95%. No gráfico, cada estudo foi representado por um quadrado de tamanho proporcional ao seu peso na metanálise. Valores de p menores que 0,05 de ambos os lados foram considerados estatisticamente significantes.

Um gráfico de funil (*funnel plot)* foi criado pela representação gráfica das estimativas individuais em unidades de logaritimo frente ao erro padrão. Para avaliar viés de publicação, a assimetria destes gráficos foi examinada e testada utilizando a correção continua de correlação de Begg e Mazumbar (12). A análise de sensibilidade *"Leave-one-out"* foi realizada, omitindo-se um estudo de cada vez e examinando a influência do estudo excluído no tamanho do efeito da medida-sumário (13).

4 – RESULTADOS

Artigo publicado no periódico *Journal of Endodontics, qualis* A1.

doi: 10.1016/j.joen.2014.10.006

Do metal post retained restorations result in more root fractures than fiber post retained restorations? A systematic review and meta-analysis

Fabrício Eneas Diniz Figueiredo*,

Paulo Ricardo Saquete Martins-Filho†,

André Luis Faria-e-Silva*

From the Department of Dentistry* and Department of Health Education†, Universidade Federal de Sergipe, Brazil.

Author to whom correspondence should be addressed:

André Luis Faria-e-Silva. Universidade Federal de Sergipe, Hospital Universitário, Laboratório de Patologia Investigativa. Rua Cláudio Batista, s/n. Bairro Sanatório. Aracaju, Sergipe, Brasil. CEP: 49060-100. Email: fariaesilva.andre@gmail.com

Running head: Root fracture of post-retained restorations

Word counts: 3536

Figures: 4

Tables: 4

Acknowledgement

The authors deny any conflicts of interest

Do metal post retained restorations result in more root fractures than fiber post retained restorations? A systematic review and meta-analysis

Abstract

Introduction: Teeth requiring endodontic treatment commonly have compromised coronal tooth structure that often requires the use of an intra-radicular post to retain the coronal restoration. Though usually successful, catastrophic failures requiring extraction have been reported in the literature. The aim of this systematic review was to analyze clinical trials and cohort studies that evaluated the incidence rate of root fractures in post retained restorations. The hypothesis was that the incidence rate related to the use of metal posts was higher than that of fiber posts. **Methods:** A MEDLINE search for clinical studies reporting the incidence of root fractures of restorations retained with fiber posts or metal posts of endodontically treated teeth with more than 5-year of follow-up was conducted from inception to January 2014. Seven randomized clinical trials and 7 cohort studies were included. **Results:** The pooled survival rate was 90% (95% CI, 85.5-93.3) for metal-based posts and 83.9% (95%, CI 67.6-92.8) for fiber-reinforced posts. The overall incidence rate of root fractures (catastrophic failures) was similar between metal and fiber posts. Prefabricated metal posts and carbon fiber posts had a 2-fold increase in the incidence rate of root fractures compared with cast metal posts and glass fiber posts, respectively. **Conclusions:** The results of this study did not demonstrated significant differences for root fractures incidence between metal- and fiber posts. However, the studies included in this review presented a high risk of bias, and further well-designed clinical studies are required to confirm these findings.

Introduction

Prefabricated fiber-reinforced posts have become more popular than cast posts for clinical usage in recent years. This may be due to enhanced esthetics and reduction in treatment time. Another factor may be that the elastic modulus between fiber posts and dentin is similar, which has been related to a reduced incidence of root fractures. (1, 2). Several *in vitro* studies have demonstrated that due to their high elastic modulus, metal posts concentrate stress on the root and promote a higher incidence of root fractures compared with fiber posts (3). In contrast, a recent study with finite element analysis has shown that the use of fiber posts resulted in higher stress on root structures compared with metal posts, primarily when the bonding between the fiber posts and the root canal surface failed - debonding (4). However, the same study demonstrated that fiber post restored roots were less prone to fracture because the risk of fracture of the core and/or post is higher than that of the root.

Clinically, a reduced incidence of catastrophic failures, which does not permits the replacement of the restoration, can be more important than the survival rate of the restoration. However, the aim of most reviews on intra-radicular posts has been to evaluate the survival rate. Thus, the aim of this systematic review was to analyze the outcome of clinical trials and cohort studies evaluating the post retained restorations regarding the incidence rate of root fractures. The hypothesis is that the incidence rate of root fractures related to the use of metal posts is higher than that of fiber posts. This study also aimed to evaluate the clinical performance of the systems with regard to their survival rate.

Materials and Methods

A protocol of this systematic review was designed a priori and was registered in the PROSPERO database (registration number CRD 42014007423).

Eligibility Criteria

Clinical studies reporting the incidence of root fractures of restorations retained with fiber-reinforced composite posts or metal posts of endodontically treated teeth were considered eligible for inclusion in this systematic review. Articles were selected if they met the following criteria: Randomized clinical trials (RCTs) and cohort studies comparing the incidence of root fractures of metallic and fiber-reinforced composite posts; RCTs and cohort

studies where one arm reported the incidence of root fracture of one system; RCTs and cohort studies with a mean/median of follow-up time of 5 years.

Studies from which we were unable to extract data for the outcomes of interest, *in vitro* studies, reviews, and studies with a mean/median of follow-up time of less than 5 years were excluded. Whenever more than one publication reported results for the same group of patients, we included only the report containing the most comprehensive data to avoid the duplication of information.

Search Strategy

A MEDLINE search for RCTs and cohort studies was conducted from inception – no limit regarding year of publication - to January 2014 using the following key terms: (“nonvital tooth” OR “devitalized tooth” OR “pulpless tooth” OR “endodontically treated tooth”) AND ("fiber post" OR "metallic post" OR "cast dowel" OR "dowel" OR "metal post" OR "carbon-fiber post" OR "glass-fiber post" OR "quartz-fiber post" OR "fiber-reinforced post" OR "post core systems" OR "post and core technique") AND (exp cohort studies OR cohort OR controlled clinical trial OR epidemiologic methods OR clinical trial). The search also included a hand search of cross-references from original articles and reviews to identify additional studies that could not be located in the MEDLINE database. In addition, dissertations and theses were searched in the OpenThesis database using a search strategy similar to the applied in the MEDLINE. No language or publication year criteria were imposed.

Data Extraction and Outcomes

Two independent reviewers screened the search results and identified studies that were potentially relevant based on the papers’ titles and abstracts. Relevant studies were read in full and selected according to the eligibility criteria. Data concerning cohort studies were extracted independently by two reviewers. Disagreement between the two reviewers was solved either by consensus or by a third reviewer.

Root fracture leading to tooth extraction was considered a catastrophic failure and defined as the primary outcome. Non-catastrophic failures were defined as the secondary outcome and included endodontic failures – failures related exclusively to the root canal

therapy, but the restoration remained intact - crown dislodgement, post debonding, and post/core fractures (6,7).

Assessment of Risk of Bias

The Cochrane Risk of Bias Tool was used to assess the quality of study methodology of eligible RCTs. The study quality was assessed independently by two reviewers using the following 7 criteria: random sequence generation; allocation concealment (selection bias); blinding of participants and personnel (performance bias); blinding of outcome assessment (detection bias); incomplete outcome data (attrition bias); selective reporting (reporting bias); and other bias (absence of description regarding tooth location or the amount of remaining coronal structure). The response for each criterion was reported as low risk of bias, high risk of bias, and unclear risk of bias (8).

The cohort studies were assessed using a modified version of the Newcastle-Ottawa Scale (NOS) (9) and included evaluations of the representativeness of the sample size, selection of a comparison group (whether participants were drawn from the same source, e.g., same institution or database), ascertainment of exposure by secure records, outcome of interest not present at start of the study, confounders or others factors used to match or control for in analysis, outcome assessment by clinical and radiographic examination, adequate follow-up period for outcome of interest ($\geq$ 5 years), and loss to follow-up unlikely to introduce bias. These items were not merged into a quality score. Instead, the relevant information for each domain was tabulated to allow for greater transparency. The NOS scale was also assessed by two reviewers, and disagreement was solved by consensus or by a third reviewer.

Data Synthesis and Analysis

The incidence rate of root fractures and non-catastrophic failures was calculated by dividing the number of events by the period of risk for all included posts during the study period, as per 1000 posts-years of follow-up. If the total number of posts-years was not reported, it was calculated by multiplying the number of posts under follow-up by the mean duration of follow-up. Confidence intervals (CIs) were based on the normal approximation and calculated using the number of posts and posts-years of follow-up. A constant 0.5 continuity correction was used for studies with zero events (10).

A meta-analysis of the crude survival rates with no adjustment for the follow-up duration was performed by dividing the number of surviving posts by the total number of posts included during the study period. A Kaplan-Meier analysis could not be performed because most of the reports did not provide a precise follow-up period for each patient. CIs were calculated using the normal approximation. When the crude survival rate in a study was reported to be 100%, we used a continuity correction with the crude survival rate set to 99%.

Statistical heterogeneity was investigated using the Cochran *Q* test and I^2 index. For the *Q*-statistic, a *p*-value of less than 0.10 was used as an indication of inter-study variability (11). I^2 was interpreted as the proportion of total variation across studies due to the variability, and a value >75% was considered a measure of high heterogeneity (12). Subgroup analyses according to the study design (RCT x cohort), sample size (<100 posts x ≥100 posts), and post system (metal post restored roots x cast metal post restored roots; reinforced carbon fiber post restored roots x reinforced glass fiber post restored roots) were conducted to explore any potential source of heterogeneity between studies. For a meta-analysis of the survival rate, a stratified analysis according to the follow-up time was performed.

The pooled estimate of the rates was calculated using the fixed-effects or random-effects models, depending on the between-study heterogeneity. In the absence of high heterogeneity, a fixed-effects model using the Mantel-Haenszel method was selected to pool the data, assuming that there was a common effect size and that the differences between single results were due to chance. When high heterogeneity was observed, the pooled estimates and the corresponding 95% CIs were calculated based on the random-effects model using the DerSimonian-Laird method. In the random-effects meta-analysis model, the rates for individual studies were assumed to vary around pooled estimates (13). The forest plot was used to present the pooled estimates and the 95% CIs graphically. Each study was represented by a square in the plot that was proportional to the study's weight in the meta-analysis. Two-sided *p*-values less than 0.05 were considered statistically significant.

A funnel plot was created by plotting the individual estimates in log units against the standard error. To assess publication bias, contour-enhanced funnel plots were examined and their symmetry was tested using the Begg and Mazumbar rank correlation with continuity correction (14). "Leave-one-out" sensitivity analysis was conducted by omitting one study at a time and examining the influence of each individual study on the pooled effect size (15).

Results

Search Results and Study Characteristics

The literature search resulted in 255 papers, 20 of which were defined as potentially relevant to the current analysis. Of these, 9 were excluded in the subsequent detailed assessments for the reasons shown in Figure 1. No dissertation and thesis was retrieved from OpenThesis database. Three other articles were included after searching the references and adding these articles to the remaining 11 studies, resulting in a total of 14 studies (7,16-28) that met our eligibility criteria and were included in the meta-analysis. The fourteen studies (7 RCTs and 7 cohort studies) included in the present analysis were published between 1991 and 2012. The pooled population comprised 3202 participants and 4752 posts, with a follow-up time of 41 721 post-years. Sixty-two root fractures and 467 non-catastrophic failures were diagnosed during the study period (Table 1).

Figure 1: Search results

Risk of Bias

Randomization and allocation concealment procedures were inadequate or unclear in the trials included in the systematic review. Failures in randomization and allocation concealment allow the clinician to predict the upcoming treatment allocation, thereby leading to selection bias. In addition, except in the study performed by Sterzenbach et al. (27), neither the patients nor the investigators were blinded to the treatment received, and the trials were classified as having a high risk of performance and detection bias. Only one study (17) had no attrition bias, and a low risk of reporting bias was observed for all trials. The absence of descriptions regarding the amount of coronal remaining and/or tooth location was also considered a bias. The quality assessment of the included trials is shown in detail in Table 2.

The risk of bias among cohort studies is reported in Table 2. The sample size was considered representative in all cohort studies, but in only three studies (18,20,21) was a comparison group selected. Ascertainment of exposure through secure records and demonstration that the outcome of interest was not present at the start of the study were observed for all cohorts. The methods used to control for confounding were not described, and a high risk of performance bias was observed. However, outcome assessment by clinical and radiographic examination was described for most studies. Although the follow-up time

was long enough to produce root fractures and non-catastrophic failures, only two cohort studies (20,25) described that a loss to follow-up was unlikely to introduce bias.

Incidence Rate of Root Fracture

Data on the incidence rate of root fractures for metal-based posts were extractable from four RCTs (16,17,22,27) and four cohort studies (19-21,28). The pooled event rate per 1000 posts-year was 5.13 (95% CI, 4.05-6.21), but an important heterogeneity was observed across studies ($p<0.001$, $I^2 = 99.8\%$). For fiber-reinforced posts, data on the incidence rate of root fractures were extractable from five RCTs (7,22,23,26,27) and three cohort studies (18,24,25). The pooled estimate per 1000 posts-year was 4.78 (95% CI, 4.28-5.27). Moreover, the inter-study heterogeneity was high ($p<0.001$, $I^2 = 100\%$) (Figure 2).

The incidence rate of root fractures for prefabricated metal posts and carbon fiber posts was 2-fold higher compared with cast metal posts and glass fiber posts (Figure 2 and Figure 3). However, subgroup analysis failed to define the reasons for heterogeneity (Table 3). There was no evidence of publication bias, as suggested by visual inspection of the funnel plot and the Begg and Mazumbar rank correlation ($p=0.063$ for metal-based posts; $p=0.107$ for fiber-reinforced posts). The sensitivity analysis showed that the pooled event rate for both systems did not change substantially with the exclusion of any one study, thereby indicating that the meta-analyses was not compromised in any way.

Incidence Rate of Non-Catastrophic Failures

Data on the incidence rate of non-catastrophic failures for metal-based posts were extractable from four RCTs (16,17,22,27) and three cohort studies (20,21,28). Using a random-effects model (heterogeneity: $p<0.001$; $I^2 = 100\%$), we found that the overall incidence rate of non-catastrophic failures for metal based posts was 12.69 (95% CI, 7.90-17.48) per 1000 posts year. For fiber-reinforced posts, an important heterogeneity was also observed ($p<0.001$; $I^2 = 100\%$), and the pooled effect size was 19.39 (95% CI, 13.21-25.57) (Figure 3).

The incidence rate of non-catastrophic failures was increased 2-fold in cast metal posts and carbon fiber posts compared with prefabricated metal posts and glass fiber posts, respectively. The reasons for heterogeneity were also not defined by subgroup analysis (Table

3). The robustness of the pooled effect size was examined by sequentially removing each study and reanalyzing the remaining datasets. For metal-based posts, omitting the cohort study of Jung et al. (21) resulted in a significant reduction in the incidence rate of non-catastrophic failures (7.27; 95% CI, 3.36-11.18), while the other studies had no substantial effect on the pooled results. However, there was no obvious evidence of publication bias in this meta-analysis (Begg's test, p=0.548). For fiber-reinforced posts, the results were not compromised by the all one-by-one study removals, and no obvious publication bias was found (Begg's test, p=0.548) (Figure 3).

Survival Rate of Post Systems

Figure 4 shows the study-specific and summary survival rates of the post systems. The pooled survival rate for metal -based posts was 90.0% (95% CI, 85.5-93.3), and a statistically significant heterogeneity among studies was observed (p=0.008, I^2 = 63%). For fiber-reinforced posts, the pooled survival rate was 83.9% (95%, CI 67.6-92.8), and an important heterogeneity (p<0.001, I^2 = 97.3%) was also observed.

To explore the sources of heterogeneity, we considered performing a stratified analysis based on the follow-up periods, according to the subgroups of post systems (Table 4). The stratified analysis showed a reduction in the overall survival rate of post systems over time. We did not observe statistical heterogeneity between studies of prefabricated metal posts, but significant changes in heterogeneity were noted in the overall analysis of survival when cast metal posts were added. For the fiber post system, heterogeneity was analyzed in three follow-up periods (4.1-6 year, 6.1-8 year, and 8.1-10 year). A severe statistical heterogeneity was observed during the 6.1-8 year follow-up, but the variability in the individual study results was not related to the type of fiber post. In addition, there was no evidence for a difference in the summary estimates by adjusting the results for the study design (results not shown). However, further analysis suggested that heterogeneity could be primarily attributed to two studies (18,26), due to variations in the sample sizes. After excluding these studies, the heterogeneity tests showed no statistically significant differences (p = 0.547; I^2 = 0.0%) in the remaining studies.

Visual inspection of the funnel plot and the Begg and Mazumbar rank correlation showed no potential for publication bias in any of the meta-analyses. The "leave-one-out" method showed that the survival rate for the adjusted and unadjusted datasets did not change

substantially with the exclusion of any one study. The results of the sensitivity analysis exclude the possibility of bias and confirm the robustness of effect sizes.

Discussion

The results of this systematic review show similarities between the incidences of catastrophic failures among metal- and fiber-post-retained restorations. There was a higher incidence of non-catastrophic failures for fiber post-restored roots, but the survival rate was similar for both types of posts. This systematic review included both clinical trials and observational cohort studies, resulting in high levels of heterogeneity among studies. Few studies evaluating metal and fiber posts were found in the literature. Thus, considering the necessity of comparing these types of posts, the one-arm design for data analysis was performed. Even the subgroup analyses did not identify the sources of heterogeneity, and the use of the one-arm design for data analysis could explain the high heterogeneity observed in the meta-analyses in the present study. Interestingly, the survival rate analysis demonstrated that the type of metal post (cast or pre-fabricated) partially explained the inter-study heterogeneity in this group. The same was not observed between the types of fiber posts (carbon or glass fiber) when the survival rate was analyzed, thereby stratifying the period of follow-up.

Despite the heterogeneity, meta-analyses of the outcomes were performed. According to Dwyer et al. (29), the decision to combine the results of individual studies in the presence of heterogeneity depends on the aim of the particular overview that is being undertaken. If the aim is to identify the direction of a possible association, as performed in the present study associating the type of posts and the incidence of failures, then even with observational data, a meta-analysis appears to be appropriate.

A recent meta-analysis of *in vitro* studies (3) evaluating the fracture strength of roots restored with metal or fiber posts demonstrated higher values for metal posts, while the use of this last type of post resulted in more catastrophic failures. Higher fracture strength can indicate longer longevity under clinical function. The results of our meta-analysis of clinical studies demonstrated a higher survival rate for metal posts than for fiber posts, primarily for longer periods of follow-up. However, the results of the present meta-analysis regarding the incidence rate of catastrophic failure contradict those observed for *in vitro* studies. In contrast

to the *in vitro* studies, a similarity in the incidence rate of catastrophic failures was observed among metal and fiber posts. Interestingly, when only clinical trials are analyzed, metal posts showed a higher incidence rate of catastrophic failures. The opposite was observed for cohort studies. Another interesting observation on sub-group analysis was the tendency to reduce catastrophic failures and increase non-catastrophic failures when cast posts (for metal-based) and glass-fiber posts (for fiber-reinforced) were used. Regardless of the confidence interval, no significant difference was observed.

Only studies using follow-up periods longer than five years were included in the present meta-analysis. A recent recommendation for conducting controlled trials on dental materials (30) advised an observational period of longer than 5 years for indirect restorations in clinical studies. All studies included in this systematic review used indirect restoration to restore the tooth that received the post, requiring follow-up periods longer than 5 years to assess the success of the restorative procedure. Furthermore, some clinical studies that were excluded due to shorter follow-up periods were older publications of included studies that reported on the same patients.

Some limitations should be acknowledged in this meta-analysis. First, almost all of the observational studies that met the inclusion criteria were retrospective cohort studies, which have less control over the subject selection and measurements and the risk for confounding. However, cohort studies often include more subjects and have a longer follow-up time. In addition, in regard to assessing harm, such as the incidence of failures, these types of studies are a good source of data. Second, studies that suffer from a high risk of bias were not excluded from the meta-analysis. This decision was made due to the lack of unbiased studies that met the inclusion criteria for this review. Finally, we were unable to explore the risk factors for the outcomes of interest, such as the amounts of coronal remaining, presence of ferule effect, location of tooth, and occlusion features. Unfortunately, these risk factors were not described in most of the included studies.

In conclusion, the results of the present systematic review based on clinical studies do not support the indication of fiber-reinforced posts based on a reduction of catastrophic failures. However, this review also demonstrated the need for further well-designed clinical studies evaluating intra-radicular posts.

References

1. Cheung W. A review of the management of endodontically treated teeth. Post, core and the final restoration. J Am Dent Assoc 2005;136:611–9.

2. Bateman G, Ricketts DNJ, Saunders WP. Fibre-based post systems: a review. Br Dent J 2003;195:43–8; discussion 37.

3. Zhou L, Wang Q. Comparison of fracture resistance between cast posts and fiber posts: a meta-analysis of literature. J Endod 2013;39:11–5.

4. Santos AF V, Meira JBC, Tanaka CB. Can fiber posts increase root stresses and reduce fracture? J Dent Res 2010;89:587–91.

6. Zicari F, Van Meerbeek B, Debels E, Lesaffre E, Naert I. An up to 3-Year Controlled Clinical Trial Comparing the Outcome of Glass Fiber Posts and Composite Cores with Gold Alloy-Based Posts and Cores for the Restoration of Endodontically Treated Teeth. Int J Prosthodont 2011;24:363–72.

7. Ferrari M, Vichi A, Fadda GM, et al. A randomized controlled trial of endodontically treated and restored premolars. J Dent Res 2012;91:72S–78S.

8. Higgins JPT, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 2011;343:d5928.

9. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M TP. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Department of Epidemiology and Community Medicine, University of Ottawa, Canada; 2000.

10. Bhaumik DK, Amatya A, Normand S-L, et al. Meta-Analysis of Rare Binary Adverse Event Data. J Am Stat Assoc 2012;107:555–67.

11. Cochran WG. The Combination of Estimates from Different Experiments. Biometrics 1954;10:101.

12. Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med 2002;21:1539–58.

13. Borenstein M, Hedges L V, Higgins JPT, Rothstein HR. A basic introduction to fixed-effect and random-effects models for meta-analysis. Res Synth Methods 2010;1:97–111.

14. Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. Biometrics 1994;50:1088–101.

15. Sterne JAC, Egger M, Smith GD. Investigating and dealing with publication and other biases in meta-analysis. BMJ 2001;323:101–5.

16. Creugers NHJ, Kreulen CM, Fokkinga WA. A 5-year prospective clinical study on core restorations without covering crowns. Int J Prosthodont 2005;18:40–1.

17. Ellner S, Bergendal T, Bergman B. Four post-and-core combinations as abutments for fixed single crowns: a prospective up to 10-year study. Int J Prosthodont 2003;16:249–54.

18. Ferrari M, Cagidiaco MC, Goracci C, et al. Long-term retrospective study of the clinical performance of fiber posts. Am J Dent 2007;20:287–91.

19. Gómez-Polo M, Llidó B, Rivero A, Del Río J, Celemín A. A 10-year retrospective study of the survival rate of teeth restored with metal prefabricated posts versus cast metal posts and cores. J Dent 2010;38:916–20.

20. Hikasa T, Matsuka Y, Mine A, et al. A 15-year clinical comparative study of the cumulative survival rate of cast metal core and resin core restorations luted with adhesive resin cement. Int J Prosthodont 2010;23:397–405.

21. Jung RE, Kalkstein O, Sailer I, Roos M, Hämmerle CHF. A comparison of composite post buildups and cast gold post-and-core buildups for the restoration of nonvital teeth after 5 to 10 years. Int J Prosthodont 2007;20:63–9.

22. King PA, Setchell DJ, Rees JS. Clinical evaluation of a carbon fibre reinforced carbon endodontic post. J Oral Rehabil 2003;30:785–9.

23. Mannocci F, Qualtrough AJE, Worthington H V, Watson TF, Pitt Ford TR. Randomized clinical comparison of endodontically treated teeth restored with amalgam or with fiber posts and resin composite: five-year results. Oper Dent 2005;30:9–15.

24. Naumann M, Koelpin M, Beuer F, Meyer-Lueckel H. 10-Year Survival Evaluation for Glass-Fiber-Supported Postendodontic Restoration: a Prospective Observational Clinical Study. J Endod 2012;38:432–5.

25. Segerström S, Astbäck J, Ekstrand KD. A retrospective long term study of teeth restored with prefabricated carbon fiber reinforced epoxy resin posts. Swed Dent J 2006;30:1–8.

26. Signore A, Benedicenti S, Kaitsas V, Barone M, Angiero F, Ravera G. Long-term survival of endodontically treated, maxillary anterior teeth restored with either tapered or parallel-sided glass-fiber posts and full-ceramic crown coverage. J Dent 2009;37:115–21.

27. Sterzenbach G, Franke A, Naumann M. Rigid versus flexible dentine-like endodontic posts--clinical testing of a biomechanical concept: seven-year results of a randomized controlled clinical pilot trial on endodontically treated abutment teeth with severe hard tissue loss. J Endod 2012;38:1557–63.

28. Weine FS, Wax a H, Wenckus CS. Retrospective study of tapered, smooth post systems in place for 10 years or more. J Endod 1991;17:293–7.

29. Dwyer T, Couper D, Walter SD. Sources of heterogeneity in the meta-analysis of observational studies: the example of SIDS and sleeping position. J Clin Epidemiol 2001;54:440–7.

30. Hickel R, Roulet J-F, Bayne S, et al. Recommendations for conducting controlled clinical studies of dental restorative materials. Clin Oral Investig 2007;11:5–33.

Figure Legends

Figure 1. Flow chart for selection of systematic review.

Figure 2. Forest plot and funnel plot for the incidence rate of root fractures according to the post-system.

Figure 3. Forest plot and funnel plot for the incidence rate of non-catastrophic failures according to the post-system.

Figure 4. Forest plot and funnel plot for survival rate of post-systems.

Table 1. Summary characteristics of included studies.

	Randomized clinical trials	Observational cohort studies	All studies
Eligible studies			
No of unique studies	7	7	14
Median (IQR) follow-up (years)	6.7 (5.9-7.8)	10.0 (8.6-10.0)	8.2 (6.6-10.0)
Participants			
Total No of participants	874	2328	3202
Median (IQR) No of participants	91.0 (59.0-151.0)	99.0 (78.5-515.0)	95.0 (75.3-173.8)
% female	54.9	68.4	65.2
Post-system			
Metal-based posts (No of studies)	4	4	8
Fiber-reinforced posts (No of studies)	5	3	8
Post-years of follow-up[¥]	7427	34 294	41 721
Outcome (No of events)*			
Root fractures	8	54	62
Non-catastrophic failures	54	413	467

[¥]Estimated from the number of transplanted patients and the mean follow-up time. *Several studies provided data on multiple outcomes of interest.

Table 2. Risk of bias of included studies.

Quality of Cohorts– using the Newcastle-Ottawa Quality Scale

Cohort, Year	Selection				Confounders and other factors	Outcome		
	Representative sample size	Selection of a comparison group	Ascertainment of exposure by secure records	Outcome not present at beginning of study		Assessment of outcome	Was follow-up long enough?	Follow-up rate ≥90%
Naumann et al., 2012	★		★	★		★	★	
Gómez-Polo et al., 2010	★		★	★		★	★	
Hikasa et al., 2010	★	★	★	★			★	★
Jung et al., 2007	★	★	★	★		★	★	
Ferrari et al., 2007	★	★	★	★		★	★	
Segerström et al., 2006	★		★	★			★	★
Weine et al., 1991	★		★	★		★	★	

Quality of RCTs –using Cochrane Risk of Bias Tool

RCT, Year	Selection		Performance	Detection	Attrition	Reporting	Other
	Random sequence generation	Allocation concealment	Blinding of participant and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	
Sterzenbach et al. (2012	Unclear risk	Unclear risk	High Risk	Low Risk	High Risk	Low Risk	Low Risk

Ferrari et al. (2012)	Unclear risk	Unclear risk	High Risk	High Risk	High Risk	Low Risk	Low Risk
Signore et al. (2009)	High Risk	Low Risk	High Risk	High Risk	High Risk	Low Risk	High Risk
Creugers et al. (2005)	Unclear risk	Unclear risk	High Risk	Unclear risk	Unclear risk	Low Risk	High Risk
Mannocci et al. (2005)	Unclear risk	Unclear risk	High Risk	High Risk	High Risk	Low Risk	Low Risk
Ellner et al. (2003)	High Risk	Unclear risk	High Risk	Unclear risk	Low Risk	Low Risk	High Risk
King et al. (2003)	Unclear risk	Unclear risk	High Risk	High Risk	High Risk	Low Risk	High Risk

Table 3. Subgroup analysis to investigate differences between studies included in the meta-analysis for incidence rate (/1000 posts-year) of root fracture and non-catastrophic failures.

Source	Root fracture					Non-catastrophic failures				
		Pooled estimates		Tests of heterogeneity			Pooled estimates		Tests of heterogeneity	
	Number of studies	IR	95% CI	p-value (Q-test)	I^2 (%)	Number of studies	IR	95% CI	p-value (Q-test)	I^2 (%)
Metal-based posts										
Study design										
RCT	4	5.01	2.28-7.74	<0.001	99.7	4	6.93	3.11-10.75	<0.001	99.9
Cohort	4	5.25	3.89-6.60	<0.001	99.9	3	20.35	12.43-28.26	<0.001	100
Sample size										
<100 posts	5	4.66	2.94-6.35	<0.001	99.6	5	14.60	4.11-25.09	<0.001	100
≥100 posts	3	5.92	4.37-7.48	<0.001	99.9	2	7.93	2.33-13.52	<0.001	100
Post-system										
Prefabricated metal post	8	5.52	4.38-6.66	<0.001	99.9	7	12.80	9.13-16.48	<0.001	100
Cast metal post	3	3.39	-0.61-7.39	<0.001	99.9	3	22.09	7.39-36.79	<0.001	100
Fiber-reinforced posts										
Study design										
RCT	5	2.91	1.67-4.16	<0.001	99.9	5	15.98	6.44-25.53	<0.001	100
Cohort	3	8.19	3.20-13.18	<0.001	100	3	25.08	6.89-43.27	<0.001	100
Sample size										
<100 posts	3	10.89	0.89-20.88	<0.001	100	3	24.35	5.28-43.41	<0.001	100
>100 posts	5	1.31	0.96-1.66	<0.001	99.9	5	16.43	9.00-23.86	<0.001	100
Post-system										
Glass fiber	3	3.58	0.62-6.54	<0.001	100	3	14.17	-4.86-33.20	<0.001	100
Carbon fiber	5	5.69	3.46-7.91	<0.001	100	5	22.56	15.04-30.08	<0.001	100

Table 4. Stratified analysis based on periods of follow-up according to the post-systems*.

Post-system/study	Period of follow-up					
	0 to 2y	**2.1 to 4y**	**4.1 to 6y**	**6.1 to 8y**	**8.1 to 10y**	**10.1 to 15y**
Metal post						
Prefabricated metal post						
Sterzenbach et al. (2012)	-	-	93.5 (81.7-97.9)	-	-	-
Gómez-Polo et al. (2010)	-	-	-	-	84.6 (66.9-94.9)	-
Hikasa et al. (2010)	99.3 (98.8-99.6)	97.0 (96.1-97.7)	94.2 (93.0-95.3)	91.4 (90.0-92.6)	86.6 (84.9-88.1)	78.7 (76.8-80.6)
Jung et al. (2007)	-	-	-	-	93.5 (92.3-94.6)	-
Creugers et al. (2005)	-	-	96.0 (85.9-99.0)	-	-	-
Ellner et al. (2003)	-	-	-	-	92.0 (67.5-99.6)	-
King et al. (2003)	100.0 (76.2-100.0)	100.0 (71.7-100.0)	100.0 (71.7-100.0)	89.0 (55.0-98.2)	89.0 (55.0-98.2)	89.0 (56.1-99.4)
Weine et al. (1991)	-	-	-	-	93.5 (88.0-96.6)	-
Subgroup survival rate	*99.3 (98.7-99.6)*	*97.0 (96.1-97.7)*	*94.2 (93.1-95.2)*	*91.4 (90.0-92.6)*	*87.0 (85.5-88.5)*	*78.7 (76.8-80.6)*
Heterogeneity (Q-test; I^2)	*p = 0.217; 34.5%*	*p = 0.814; 0.0%*	*p = 0.939; 0.0%*	*p = 0.778; 0.0%*	*p = 0.893; 0.0%*	*p = 0.417; 0.0%*
Cast metal post						
Gómez-Polo et al. (2010)	-	-	-	-	82.6 (73.5-89.5)	-
Hikasa et al. (2010)	97.0 (94.9-98.4)	93.7 (91.0-95.9)	89.6 (86.1-92.3)	82.5 (78.4-86.1)	75.5 (71.0-79.7)	55.4 (50.3-60.4)
Jung et al. (2007)	-	-	-	-	90.2 (78.1-96.8)	-
Ellner et al. (2003)	-	-	-	-	100.0 (80.7-100.0)	-
Subgroup survival rate	*97.0 (94.9-98.4)*	*93.7 (91.0-95.9)*	*89.6 (86.1-92.3)*	*82.5 (78.4-86.1)*	*82.0 (72.5-88.7)*	*55.4 (50.3-60.4)*
Heterogeneity (Q-test; I^2)	*NA*	*NA*	*NA*	*NA*	*p = 0.073; 56.9%*	*NA*
Overall survival rate	**98.3 (94.2-99.5)**	**96.2 (95.3-97.0)**	**93.0 (89.4-95.4)**	**87.9 (77.7-93.7)**	**87.0 (81.6-91.0)**	**72.7 (50.2-87.6)**
Heterogeneity (Q-test; I^2)	p = 0.001; 84.8%	p = 0.010; 78.4%	p = 0.027; 63.6%	p < 0.001; 92.2%	p < 0.001; 77.9%	p < 0.001; 97.6%
Fiber post						
Carbon fiber						
Ferrari et al. (2007)	-	-	-	92.0 (90.1-93.6)	-	-
Segerström et al. (2006)	-	-	-	65.0 (55.1-73.7)	-	-
Mannocci et al. (2005)	-	-	90.0 (82.8-94.4)	-	-	-
King et al. (2003)	93.8 (72.8-99.7)	85.7 (60.3-97.5)	78.6 (52.1-94.2)	71.0 (45.4-87.8)	71.0 (45.4-87.8)	-
Subgroup survival rate	*93.8 (72.8-99.7)*	*85.7 (60.3-97.5)*	*88.1 (81.1-92.8)*	*79.5 (48.1-94.2)*	*71.0* (45.4-87.8*)*	-
Heterogeneity (Q-test; I^2)	*NA*	*NA*	*p = 0.192; 41.2%*	*p <0.001; 96.7%*	*NA*	*NA*
Glass fiber						
Sterzenbach et al. (2012)	-	-	90.2 (77.5-96.1)	-	-	-
Naumann et al. (2012)	-	-	-	-	46.0 (38.2-54.0)	-
Ferrari et al. (2012)	-	-	-	71.0 (64.9-76.4)	-	-
Signore et al. (2009)	-	-	-	98.5 (97.0-99.3)	-	-
Subgroup survival rate	*NA*	*NA*	*90.2 (78.1-96.8)*	*92.6 (33.2-99.7)*	*46.0 (38.1-54.7)*	*NA*
Heterogeneity (Q-test; I^2)	*NA*	*NA*	*NA*	*p <0.001; 98.6%*	*NA*	*NA*

Overall survival rate	**93.8 (72.8-99.7)**	**85.7 (60.3-97.5)**	**89.1 (83.2-93.0)**	**86.0 (67.6-94.7)**	**54.6 (31.0-76.2)**	**NA**
Heterogeneity (Q-test; I^2)	NA	NA	p = 0.514; 0.0%	p <0.001; 97.3%	p = 0.118; 49.2%	NA

*Data reported as survival rate, followed by the 95% confidence interval in parentheses.

Figure 1

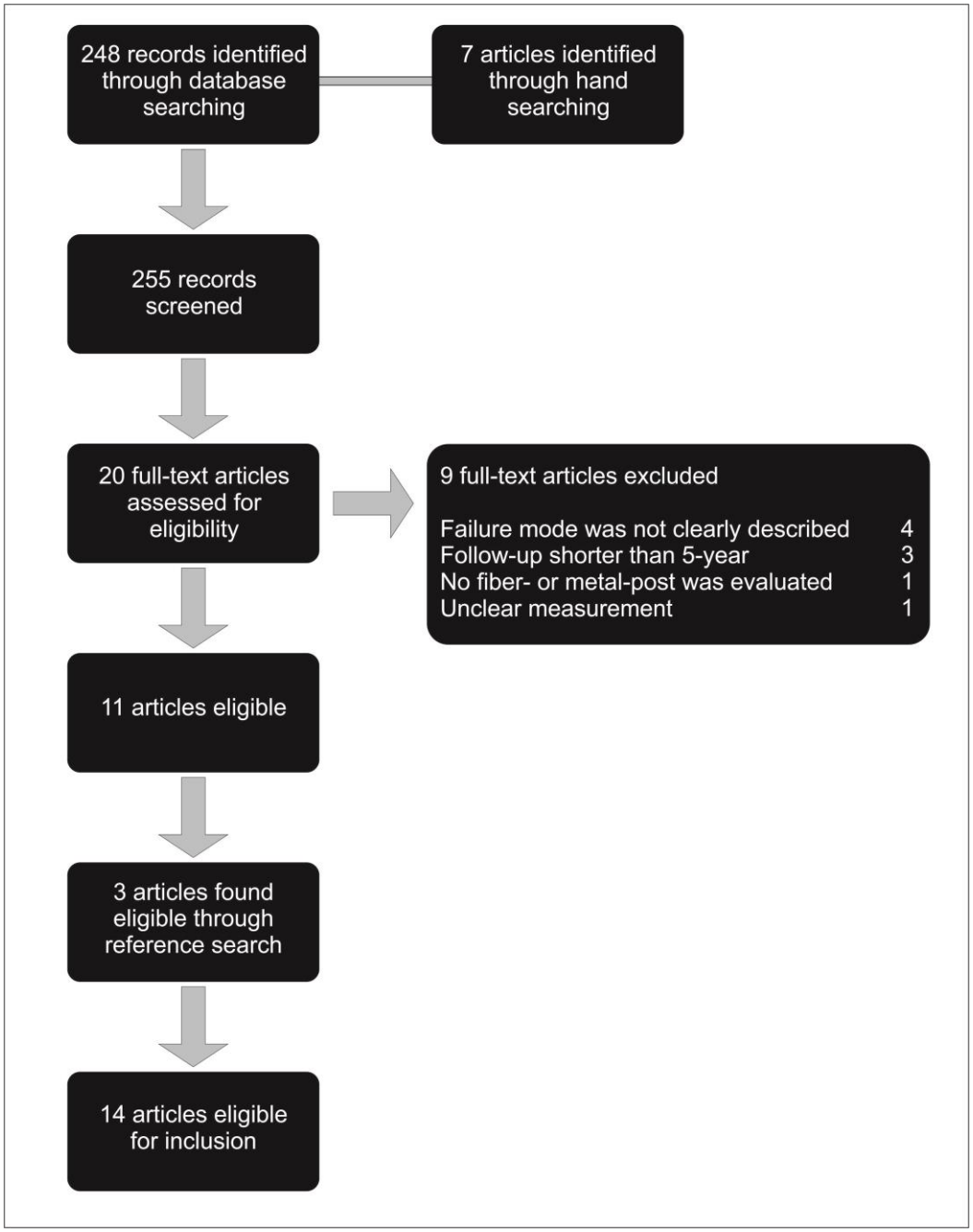

248 records identified through database searching
7 articles identified through hand searching
255 records screened
20 full-text articles assessed for eligibility
9 full-text articles excluded
Failure mode was not clearly described 4
Follow-up shorter than 5-year 3
No fiber- or metal-post was evaluated 1
Unclear measurement 1
11 articles eligible
3 articles found eligible through reference search
14 articles eligible for inclusion

Figure 2

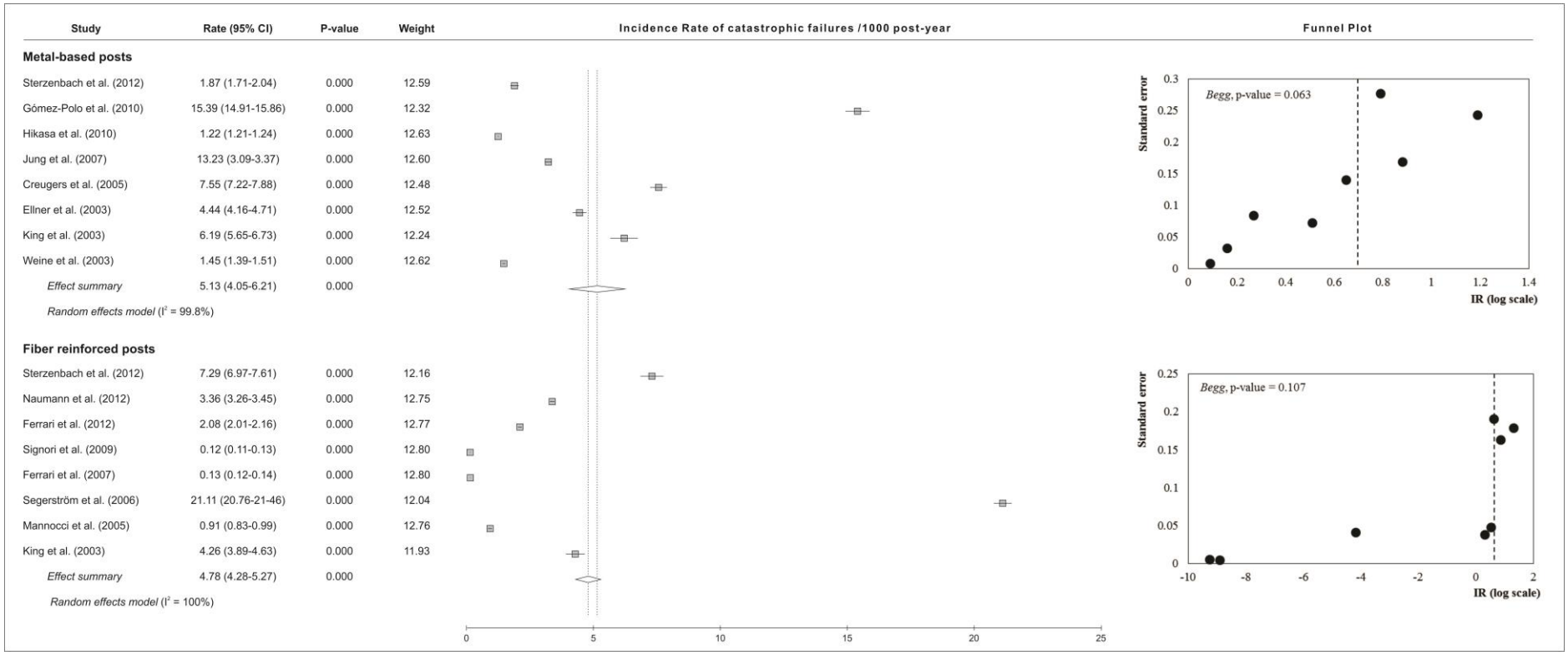

Study
Rate (95% CI)
P-value
Weight
Incidence Rate of catastrophic failures /1000 post-year
Funnel Plot
Metal-based posts
Sterzenbach et al. (2012) 1.87 (1.71-2.04) 0.000 12.59
Gómez-Polo et al. (2010) 15.39 (14.91-15.86) 0.000 12.32
Hikasa et al. (2010) 1.22 (1.21-1.24) 0.000 12.63
Jung et al. (2007) 13.23 (3.09-3.37) 0.000 12.60
Creugers et al. (2005) 7.55 (7.22-7.88) 0.000 12.48
Ellner et al. (2003) 4.44 (4.16-4.71) 0.000 12.52
King et al. (2003) 6.19 (5.65-6.73) 0.000 12.24
Weine et al. (2003) 1.45 (1.39-1.51) 0.000 12.62
Effect summary 5.13 (4.05-6.21) 0.000
Random effects model (I² = 99.8%)
Fiber reinforced posts
Sterzenbach et al. (2012) 7.29 (6.97-7.61) 0.000 12.16
Naumann et al. (2012) 3.36 (3.26-3.45) 0.000 12.75
Ferrari et al. (2012) 2.08 (2.01-2.16) 0.000 12.77
Signori et al. (2009) 0.12 (0.11-0.13) 0.000 12.80
Ferrari et al. (2007) 0.13 (0.12-0.14) 0.000 12.80
Segerström et al. (2006) 21.11 (20.76-21-46) 0.000 12.04
Mannocci et al. (2005) 0.91 (0.83-0.99) 0.000 12.76
King et al. (2003) 4.26 (3.89-4.63) 0.000 11.93
Effect summary 4.78 (4.28-5.27) 0.000
Random effects model (I² = 100%)
0
5
10
15
20
25
Standard error
Begg, p-value = 0.063
IR (log scale)
Standard error
Begg, p-value = 0.107
IR (log scale)

Figure 3

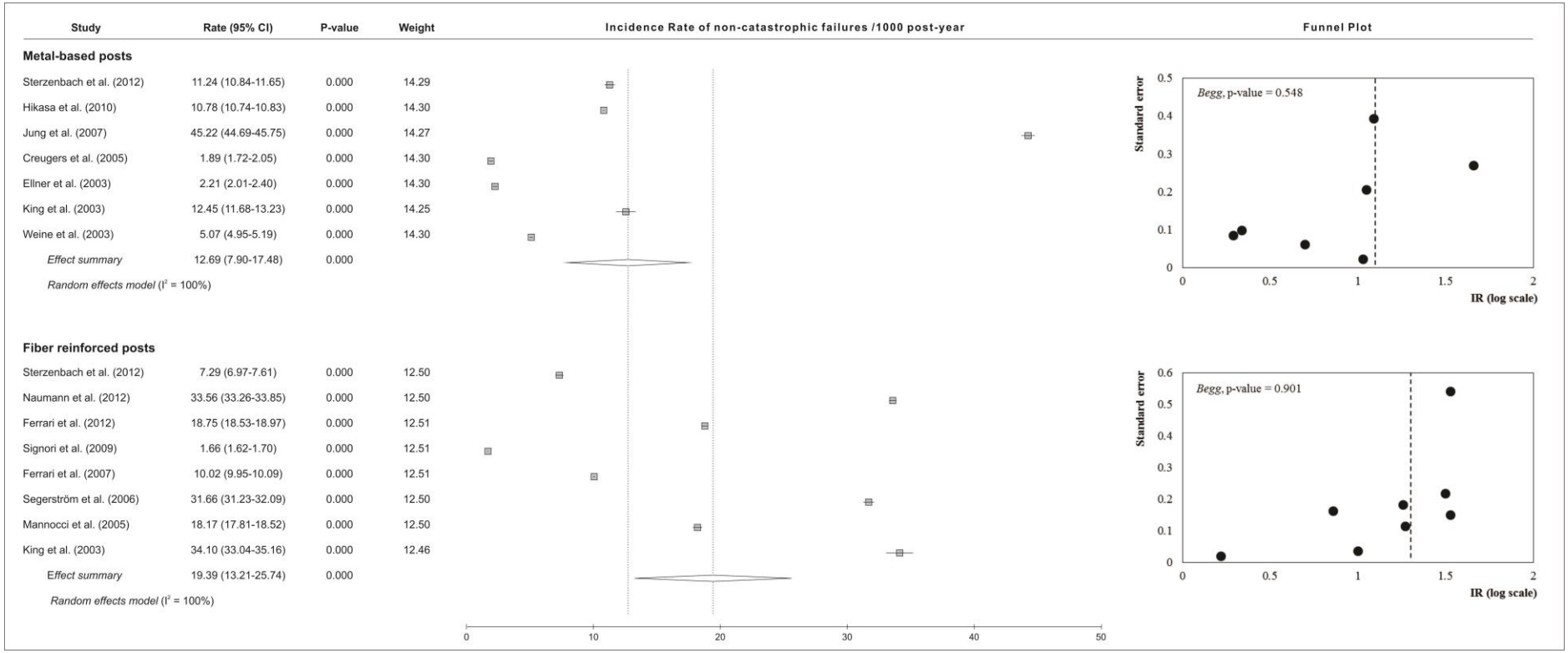
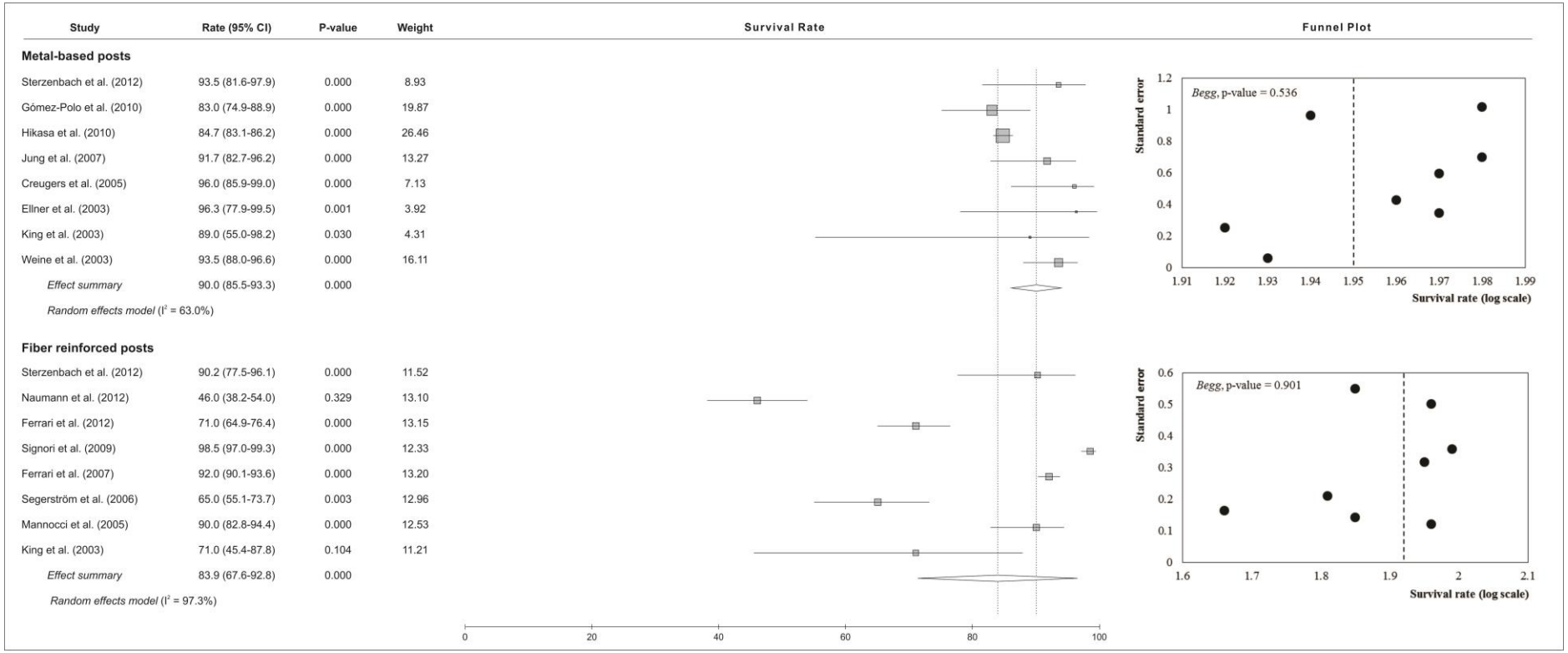

Study
Rate (95% CI)
P-value
Weight
Incidence Rate of non-catastrophic failures /1000 post-year
Funnel Plot
Metal-based posts
Sterzenbach et al. (2012) 11.24 (10.84-11.65) 0.000 14.29
Hikasa et al. (2010) 10.78 (10.74-10.83) 0.000 14.30
Jung et al. (2007) 45.22 (44.69-45.75) 0.000 14.27
Creugers et al. (2005) 1.89 (1.72-2.05) 0.000 14.30
Ellner et al. (2003) 2.21 (2.01-2.40) 0.000 14.30
King et al. (2003) 12.45 (11.68-13.23) 0.000 14.25
Weine et al. (2003) 5.07 (4.95-5.19) 0.000 14.30
Effect summary 12.69 (7.90-17.48) 0.000
Random effects model (I² = 100%)
Fiber reinforced posts
Sterzenbach et al. (2012) 7.29 (6.97-7.61) 0.000 12.50
Naumann et al. (2012) 33.56 (33.26-33.85) 0.000 12.50
Ferrari et al. (2012) 18.75 (18.53-18.97) 0.000 12.51
Signori et al. (2009) 1.66 (1.62-1.70) 0.000 12.51
Ferrari et al. (2007) 10.02 (9.95-10.09) 0.000 12.51
Segerström et al. (2006) 31.66 (31.23-32.09) 0.000 12.50
Mannocci et al. (2005) 18.17 (17.81-18.52) 0.000 12.50
King et al. (2003) 34.10 (33.04-35.16) 0.000 12.46
Effect summary 19.39 (13.21-25.74) 0.000
Random effects model (I² = 100%)
0
10
20
30
40
50
Standard error
Begg, p-value = 0.548
IR (log scale)
Standard error
Begg, p-value = 0.901
IR (log scale)

Figure 4


Study
Rate (95% CI)
P-value
Weight
Survival Rate
Funnel Plot
Metal-based posts
Sterzenbach et al. (2012) 93.5 (81.6-97.9) 0.000 8.93
Gómez-Polo et al. (2010) 83.0 (74.9-88.9) 0.000 19.87
Hikasa et al. (2010) 84.7 (83.1-86.2) 0.000 26.46
Jung et al. (2007) 91.7 (82.7-96.2) 0.000 13.27
Creugers et al. (2005) 96.0 (85.9-99.0) 0.000 7.13
Ellner et al. (2003) 96.3 (77.9-99.5) 0.001 3.92
King et al. (2003) 89.0 (55.0-98.2) 0.030 4.31
Weine et al. (2003) 93.5 (88.0-96.6) 0.000 16.11
Effect summary 90.0 (85.5-93.3) 0.000
Random effects model (I² = 63.0%)
Fiber reinforced posts
Sterzenbach et al. (2012) 90.2 (77.5-96.1) 0.000 11.52
Naumann et al. (2012) 46.0 (38.2-54.0) 0.329 13.10
Ferrari et al. (2012) 71.0 (64.9-76.4) 0.000 13.15
Signori et al. (2009) 98.5 (97.0-99.3) 0.000 12.33
Ferrari et al. (2007) 92.0 (90.1-93.6) 0.000 13.20
Segerström et al. (2006) 65.0 (55.1-73.7) 0.003 12.96
Mannocci et al. (2005) 90.0 (82.8-94.4) 0.000 12.53
King et al. (2003) 71.0 (45.4-87.8) 0.104 11.21
Effect summary 83.9 (67.6-92.8) 0.000
Random effects model (I² = 97.3%)
0
20
40
60
80
100
Standard error
Begg, p-value = 0.536
1.2
1
0.8
0.6
0.4
0.2
0
1.91
1.92
1.93
1.94
1.95
1.96
1.97
1.98
1.99
Survival rate (log scale)
Standard error
Begg, p-value = 0.901
0.6
0.5
0.4
0.3
0.2
0.1
0
1.6
1.7
1.8
1.9
2
2.1
Survival rate (log scale)

5 - Considerações Finais

Os resultados desta revisão sistemática de estudos clínicos não dão suporte à indicação de pinos de fibra reforçados com o objetivo de reduzir o risco de ocorrência de falhas catastróficas. Além disto, esta revisão também demostrou que há necessidade de serem realizados mais estudos clínicos - bem delineados - que avaliem o desempenho de retentores intrarradiculares.

6 - Comunicado à Imprensa

Restaurações dentárias que utilizam pinos metálicos têm o mesmo desempenho clínico que restaurações que utilizam pinos de resina reforçados por fibra, dizem pesquisadores

Pesquisadores da área de odontologia da Universidade Federal de Sergipe – UFS – divulgaram resultado de pesquisa na qual não foi observada diferença no desempenho clínico entre restaurações dentárias que utilizam pinos metálicos comparada com aquelas que utilizam pinos de resina reforçados por fibra, no que concerne sua longevidade e a ocorrência de efeitos colaterais, como fraturas na raiz do dente.

Dentes que passaram por tratamento de canal geralmente precisam de restaurações dentárias que apresentam pinos como um de seus componentes. Os pinos são instalados dentro das raízes dos dentes com o objetivo de impedir que a restauração se desloque e se solte do dente. Eles podem ser feitos tanto de diversas ligas metálicas como de resinas reforçados por fibras de vidro ou de carbono. Os pesquisadores da UFS investigaram se um tipo de pino é superior ao outro e concluíram que os dois pinos apresentam desempenho clínico semelhante.

Para chegar a esta conclusão, os pesquisadores tentaram identificar todos os estudos clínicos sobre o assunto e agruparam os resultados destes estudos em uma única análise estatística, processo este chamado de Revisão Sistemática e Metanálise. A pesquisa completa está publicada na revista "Journal os Endodontics" - uma das mais conceituadas na área de endodontia.

REFERÊNCIAS

1. Cheung W. A review of the management of endodontically treated teeth. Post, core and the final restoration. J Am Dent Assoc 2005;136:611–9.
2. Bateman G, Ricketts DNJ, Saunders WP. Fibre-based post systems: a review. Br Dent J 2003;195:43–8; discussion 37.
3. Zhou L, Wang Q. Comparison of fracture resistance between cast posts and fiber posts: a meta-analysis of literature. J Endod 2013;39:11–5.
4. Santos AF V, Meira JBC, Tanaka CB, et al. Can fiber posts increase root stresses and reduce fracture? J Dent Res 2010;89:587–91.
5. Ferrari M, Vichi A, Fadda GM, et al. A randomized controlled trial of endodontically treated and restored premolars. J Dent Res 2012;91:72S–78S.
6. Higgins JPT, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 2011;343:d5928.
7. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M TP. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Department of Epidemiology and Community Medicine, University of Ottawa, Canada; 2000.
8. Bhaumik DK, Amatya A, Normand S-L, et al. Meta-Analysis of Rare Binary Adverse Event Data. J Am Stat Assoc 2012;107:555–67.
9. Cochran WG. The Combination of Estimates from Different Experiments. Biometrics 1954;10:101.
10. Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med 2002;21:1539–58.
11. Borenstein M, Hedges L V, Higgins JPT, Rothstein HR. A basic introduction to fixed-effect and random-effects models for meta-analysis. Res Synth Methods 2010;1:97–111.
12. Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. Biometrics 1994;50:1088–101.
13. Sterne JAC, Egger M, Smith GD. Investigating and dealing with publication and other biases in meta-analysis. BMJ 2001;323:101–5.